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CONDITION MONITORING OF LUBRICANTS USING WEAR DEBRIS ANALYSIS

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ABSTRACT

Condition monitoring or predictive maintenance is the most commonly used technique to eliminate the failure of a machine and thereby increasing production time. This is a non-destructive method to foresee the problems within the machine well in advance. There area number of valid techniques available for condition monitoring. In this work a device has been fabricated and tested to identify the wearer particles which are present in the lubricating oil. Oil samples are collected at a regular intervals and tested for presence of worn out particles and hence leading to health assessment of the machine. The worn out particles both ferrous and non-ferrous can be identified with a photo diode which in turn activate a LED and also a circuit to give sound alarm. The device can also detect the ferrous particles with the help of a magnet, which encloses the oil tube.

KEYWORDS: Condition Monitoring, Wear Debris, Photodiode & Magnetic Pick-up

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Original Article

INTRODUCTION

Techniques and apparatus for continuous on-line debris detection and oil analysis become more sought after in these modern times. During normal machine operation small debris particles on the order 1 to 10 microns are generated. When abnormal wear begins, large debris particles in the range of 10 to 150 microns are produced. The particle size and concentration will increase gradually until machine failure. Therefore, continuous monitoring of wear debris is essential to prevent catastrophic failure of machines. Xiaoliang Zhu et al.[1] in their work have presented a wear debris sensor consisting of 3×3 sensing channels for online lubricant oil condition monitoring . Z.Peng et al. [2] have conducted experiments on lubricating oil of a worm gear box in their work. They have added different contaminant particles to the lubricating oils of different grades. Numerical data produced by wear debris analysis have been compared with vibration spectrum. S. Ebersbach et al.[3] in their work discussed the use of the numerical approach for wear debris analysis facilitated by the use of a laser scanning confocal microscope. Om Prakash Sondhiya and Amit Kumar Gupta [4] have emphasized on wear debris analysis of automotive engine lubricating oil using ferrography and concluded that ferrography helps improving filtration efficiency and frequency of oil cleaning system through a centrifuge or magnetic particle separation system. Y. Iwai et al.[5] have taken up diagnostic technique that can eliminate quantitative wear amounts under lubricated condition. Roman Jar Anek et al.[6] in their work have analyzed wear debris through classification of the particles based on machine

learning. W. W. Seifert and V.C. West coast [7] have developed an instrument which is capable of precipitating magnetic particles in lubricating oils. N. Govindarajan and R. Ganamoorthy [8] have taken-up an investigation to predict where morphology of porous steel. V. Macia N, et al.[9] have taken-up an analytical approach to wear rate determination for internal combustion engine condition monitoring based on oil analysis. R.T. Lewis [10] has introduced a technique to detect the paramagnetic as well as the ferromagnetic particles in a used lubricant. T.B. Krik et al.[11] have taken-up computer image analysis of wear debris for machine condition monitoring and fault diagnosis. Z. Peng et al.[12] have developed techniques for three-dimensional imaging of wear particle analysis. Z. Peng and T.B. Kirk [13] have applied two-dimensional fast Fourier transform and power spectrum for wear particle analysis. Matthew Paul Appleby [14] has worked on wear debris detection and oil analysis using ultrasonic and capacitance measurements. K.V. Ramana et al.[15] have taken up condition monitoring through oil analysis using an expert system by their oil properties. K.V. Ramana and K.L. Narayana [16] have worked on condition monitoring of fan lubricating oil

EXPERIMENTAL SETUP

The schematic diagram of the fabricated device is shown in Figure 1. A pictorial view has been presented in Figure 2

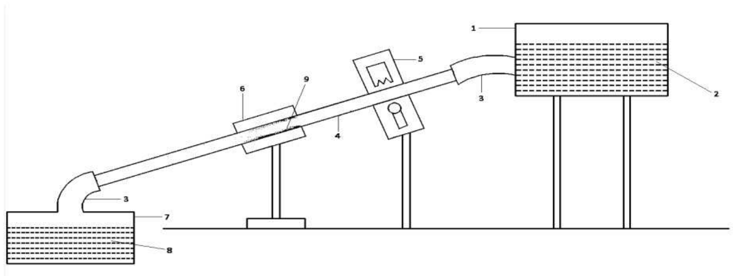

Figure 1: Schematic Diagram

Legend

- Lubricating Oil Tank 2. Oil to be tested 3. Pipe 4. Glass Tube 5. Sensing Circuit (Photo Detector) 6. Magnetic Plug 7. Storage Tank 8. Tested Oil 9. Wear Debris Particles

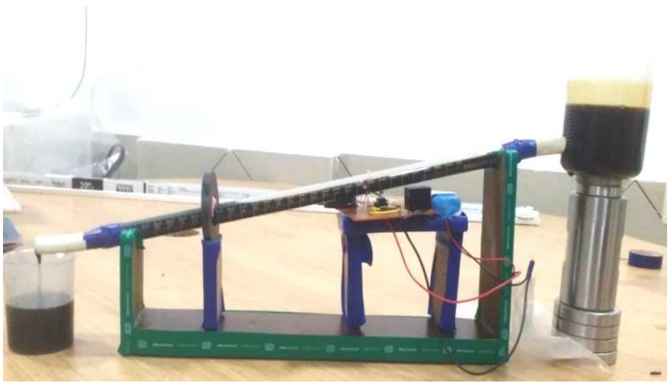

Figure 2.1: Front View

Figure 2.2: Top View

Figure 2.3: Left Side View

CIRCUIT DIAGRAM OF SENSOR

Figure 3 shows the circuit diagram of the proposed sensor which gives both visual and audio signal

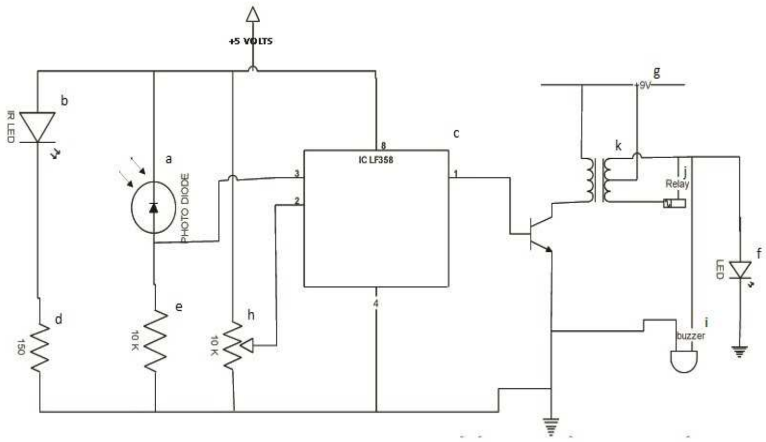

Figure 3: Photo Detector Circuit

Components of the Circuit

(a) Photo Diode (b) IR LED (c) LM358 IC (d) 150Ω Resistors (e) 10 KΩ Resistor (f)LED Bulb (g) 9V Battery for Current supply (h) 10 KΩ Preset (i) Buzzer (j)Relay (k)Transformer

METHODOLOGY

The oil sample to be tested is taken from the drain plug of the lubricating oil tank of a four stage multi speed gear box. The oil is fed into the glass tube through gravity by keeping it at an angle of 30^0 to the horizontal. The photo detector detects initially the presence of wear particles of both ferrous and non-ferrous materials. The circuit will give a visual display through Led bulb and also a buzzer sound simultaneously if any wear particle is present in the lubricating oil. The permanent magnet which encloses the glass tube will attract the particles of ferrous in nature and accumulate in the glass tube and deposited at the bottom of the glass tube

EXPERIMENTAL INVESTIGATION

The deposition of ferrous particles can be maintained at regular intervals in two ways (i) Weighing the deposited wear particles and (ii) Taking up a microscopic analysis of the colour, shape and size of the particles, which will provide a

guide for deterioration activity. Based on the observations, it can be concluded upon over an excess contact taking place leading to wear

CONCLUSIONS

Oil monitoring technique is a valuable failure analysis tool, although less work has been published on this subject. The advantages of the proposed techniques are easy to understand and free from sophisticated sensors and their mechanisms, simple but effective and online monitoring of oil is possible by locating the proposal device appropriately in the oil circulation system.

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